Using Spaceborne Ku-Band Scatterometer for Global Snow Cover Monitoring

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Abstract

We demonstrate for the first time the utility of spaceborne Ku-band scatterometer for global snow cover monitoring. Satellite radar data were collected over the globe by the NASA Scatterometer (NSCAT) operated at 14 GHz on board the Japanese ADEOS spacecraft from September 1996 to June 1997, spanning the 1997 seasonal snow season.

First, we present backscatter signature of dry and wet snow to facilitate the interpretation of NSCAT backscatter evolution over snow cover regions. Surface field experiments indicated that dry snow backscatter at Ku band is approximately 40 times stronger than that at C band. Thus, Ku-band scatterometer measurements are sensitive to snow cover, which is typically transparent to C-band scatterometer returns. Furthermore, Ku-band backscatter does not saturate for most of natural snow depths as compared to radar responses at 19 GHz and 37 GHz or higher frequencies which have more limited penetration depths into snow. Ku-band backscatter is also sensitive to wetness in snow, which is appropriate to detect early snow melt conditions.

Using the snow backscatter characteristics, we investigate NSCAT backscatter evolution over global snow cover regions throughout the 1997 snow season. The results reveal detail delineations between different regional snow areas. We show the correlation of these delineations with the boundaries of different global snow classes defined by the U.S. Army Cold Regions Research and Engineering Laboratory snow classification system. Using in-situ snow depth data from the U.S. National Climatic Data Center, we show that Ku-band backscatter corresponds very well to the trend of snow melt while snow mapping products (U.S. Climate Prediction Center gridded snow charts) from visible sensors does not reflect the fast snow melt trend. To illustrate the practical application of global snow monitoring with spaceborne Ku-band scatterometer, we present NSCAT backscatter response corresponding to the snow event leading to the 1997 Flood of the Century over the U.S. Northern plains and the Canadian prarie region, which caused loss of lives and several billion dollars in flood related damages and cleanup costs. Finally, we show that the fixed incidence configuration of Seawinds scatterometers, to be launched on QuickSCAT and on ADEOS-2 in the near future, is better for snow monitoring and then discuss the use of future high-resolution scatterometers for global snow mapping.